Job Reallocation and Labour Mobility among Heterogeneous Firms in Norway

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Preface

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1 Introduction

International Trade, R&D and knowledge activity are often considered to be the potential sources of growth for individual firms and the whole economy. Considerable attention has been attracted to these topics. For example, empirical research finds a significant and positive relationship between productivity growth and R&D intensity at the firm level. Klette and Kortum (2004) construct a dynamic model and demonstrate that "The firm-level evidence … supports the view that R&D is crucial for aggregate growth". The impact of international trade on growth has also been proved both theoretically and empirically. For instance, studies indicate that liberalization in international trade accelerates the growth of the exporting sectors, while international trade contributes to aggregate productivity growth by generating reallocations of inputs and outputs from less productive to more productive establishments.[1]

Empirical evidence suggests that internationalization strategy, R&D intensity and knowledge activity level are substantially different across firms in the industry. However, we have known very little about whether the labour dynamics are heterogeneous among the firms which are different with respect to these three aspects. This paper will study the labour dynamics of Norwegian firms using the information about firms' employment, internationalization strategies in terms of export and import, R&D intensities and knowledge activity levels in production measured by the education level of their employees.

Impact of international trade, R&D and knowledge activity on aggregate productivity growth depends on individual firms' growth, firms' entry, and firms' exits, moreover on the labour market dynamics related to changes within and between firms. To know better the impact of international trade, R&D and knowledge activity on aggregate productivity growth in the Norwegian economy, we have to know about the job reallocation, labour mobility and the change of the labour composition in Norwegian labour market.

[1] Studies can be found from Alvarez *et al.* (2005), Clerides *et al.* (1998), Eaton *et al.* (2006), Melitz (2003) and so on.

By using the micro data, we are able to distinguish firms carefully in terms of their status in international trade, R&D intensity and knowledge activity level. The advantage of this paper comes from the multi-aspect when I classify the firms. For example, I not only study the employment of firms in international trade, but also study the employment of firms in international trade with different R&D intensity levels. This allows us to explore the labour market dynamics in more detail.

To study job reallocation, I investigate net job growth, job creations and job destructions of firms in both manufacturing and market service sector. In the study of manufacturing, I divide firms into groups by their status in international trade and the level of R&D-intensity. By exploiting this, we aim to get knowledge about how the jobs are reallocated between manufacturing and the market service sector, and within manufacturing between exporters and non-exporters, high R&D-intensive industries and low R&D-intensive industries. In order to investigate the knowledge activity levels represented by the composition of the labour force in different sectors and firms, all workers are divided into three groups according to high, medium and low education-level. Worker mobility and worker reallocation are also studied, therefore we can discover whether there is heterogeneity in the composition of the workforce and their stability and mobility in different categories of firms. The heterogeneity in labour dynamics may explain partly the differences in other aspects of firm characteristics. Moreover, worker mobility is important in that it is often considered to be an important source of knowledge externality, and worker reallocation may play an important role in the productivity growth at the firm and industry level.

The main results found in this paper are as follows. There has been a downsizing of manufacturing in Norway from 1996 to 2005 mainly through decreased job creations. Even so, there has been positive net job growth in exporters and the high R&D-intensive industries in manufacturing. The positive net job growth in exporters is mainly attributed to net entry and net growth of jobs from firms which changed from non-exporters to exporters. Among all exporters, high R&D-intensive exporters have particularly high net job growth

rates. With respect to labour composition and worker mobility, R&D intensive exporters have the highest share of skilled workers and the most rapid upgrading in their labour composition. Employees in exporting firms are more stable than those in non-exporting firms, and the worker stability increases with employees' education level. Workers from exporting firms more likely find new jobs in exporters, while workers from non-exporting firms have higher probability to find jobs in non-exporters than the workers from exporters. However, there are more workers reallocated from non-exporters to exporters than from exporters to non-exporters. The share of mobile workers who find a new job within one year after leaving the previous job is increasing with education level, which suggests that there has been a higher demand biased towards skilled workers in the labour market.

The theoretical principles used in this paper are mainly followed from labour market theories. Data resources are linked employer-employee data, trade data and account data of Norwegian firms accessed from Frisch Centre. STATA is the software used for calculations.

The rest of this paper is structured as follows. Section 2 presents the data source. Section 3 has two parts. The first part provides descriptive review of the macro-economy and international trade in Norway from 1996 to 2005. The second part presents empirical evidence of the difference between trading and non-trading firms in manufacturing in Norway. Section 4 describes theories of gross job flows and labour dynamics, followed by the results from applying the theoretical concepts and principles in section 5. Conclusions are drawn in section 6.

2 Data

I use three kinds of data sets which cover 10 years from 1996 to 2005. The first is the employer-employee data. This data set links each employee to his/her employer at every work position by the unique identity number for every employee and employer. Therefore, we can find out the date when an employment relation started and when it ended. Work-hour, wage, tenure of

workers at each job position and sector classification of firms by NACE (Standard Industrial Classification) codes are also available in this data set. Moreover, the data set contains basic demographic information about workers, such as age, gender, education, and so on. The data set includes the whole population of workforce in Norwegian labour market except the self-employed. Second is the trade data which documents the trade of all Norwegian firms that imported or exported by year, except the firms in the oil industry. There are identity number, importing values and exporting values as well as destinations of exports and source countries of imports for each firm. The third is the account data which contains account information of firms, such as incomes and costs, capital and assets, profits, and so on. There is also information about firms' leaders in this data. Of course, identity numbers of firms are also available. Because the identity number for each firm and each employee is unique, the three data sets can be linked to each other.

The data allows for the construction of variables such as job creation rate, job destruction rate, net job growth rate and job reallocation rate, as well as worker stability and mobility for the whole economy and for manufacturing and market service sector separately. The job flows and worker reallocations can also be investigated at the level of subsector grouped according to firms' status in international trade and R&D intensity. Further information about the data is given in the appendix.

3 Economic background

3.1 Macro-economy and International trade from 1996 to 2005

After the recession in the end of 1980s, the Norwegian economy experienced a recovery and relatively stable growth in the 1990s, and the GDP growth rate picked up in 1996 and 1997 (Hunnes *et al.*, 2008). Table 1 shows unemployment rate and GDP growth rate in the years from 1996 to 2005 for the whole economy and separate GDP growth rate for manufacturing and the market service sector.

From Table 1 we can see that there was a small slowdown in the growth of the whole economy after 1997, while the growth of manufacturing and market service sector were very different. The manufacturing fluctuated more and experienced negative growth in some years, whereas the market service sector has undergone steady increases in all the years. The differences between these two sectors are also reflected in the ratios of their production values to the total GDP. The ratio of manufacturing did not change significantly.[2] However, the ratio of market service sector increased from 26% to 32% from 1996 to 2005. The ratio of the employment in manufacturing to the total employed persons in Norway decreased from 15% in 1996 to 11.7% in 2005. Comparatively, this ratio of market service sector has increased from 35.6% to 37.4%.[3]

Table1: Macroeconomic development: unemployment rate and GDP growth rate

Year	*Unemployment rate*[a]	*GDP growth rate (% change of annual value)*[b]		
		Whole economy	*Manufacturing*	*Market service*
1996	4.8	4.86	1.25	4.40
1997	4.0	4.91	3.88	5.88
1998	3.2	1.01	1.87	5.95
1999	3.2	0.67	-2.00	4.40
2000	3.4	3.77	-1.22	5.16
2001	3.6	1.87	2.75	1.58
2002	3.9	0.97	-0.48	0.83
2003	4.5	0.66	3.58	1.22
2004	4.5	2.59	5.31	4.45
2005	4.6	1.46	3.84	4.65

Notes:
a) The unemployment rates are taken from the UN website.
b) The GDP growth rate is computed based on the data from Statistics Norway. The calculation method is followed from Hunnes *et al.* (2008).

[2] The ratio of manufacturing in the national GDP fluctuated from 10.1% in 1996 to 9.2% in 2002 and 10% in 2005.

[3] The results are computed based on the data from StatBank of Statistics Norway.

It is well-known that Norway has been trading extensively with other countries. Before the 1980s, imports were much higher than exports in Norway. But since 1990, exporting has been growing dramatically compared with importing, inducing a positive and continually increasing trade balance. This feature becomes more and more striking after 2000. Even though this development is largely due to the fact that Norway has been exporting tremendous amounts of oil and gas to other countries every year, it is still notable that international trade in other economic fields also experienced a significant growth.

Given the relatively small Norwegian domestic market and the trend of globalization, manufacturing in Norway has especially close connection with international markets. The ratio of firms trading abroad to the total number of firms in manufacturing is remarkable, and increased from 45% in 1996 to 56% in 2005. The number of firms in manufacturing exporting or importing has grown by 23%, even though the size of the whole manufacturing has been shrinking. Among the changes, the number of exporters has increased by 27%. The ratio of exporters which are also importers rises from 83% to 91.5%, meanwhile the ratio of importers which also export grows from 51% to 55%. The ratio of the value of manufacturing products exported and imported to the national GDP increases from 23% to 30% in the period from 1996 to 2005.[4]

There has also been growth in the internationalization of the market service sector, although the magnitude is not as large as those of manufacturing. From 1996 to 2005, the number of firms in market service sector participated in international trade has grown by 17%. The ratio of the values of products exported or imported in market service sector to the national GDP increases from 14% to 16.7%. International shipping contributes the most to the revenues from the trade in services.[5]

[4] All numbers here are computed based on the data from employer-employee data, trade data and data on statistics Norway website.

[5] From the website of Statistics Norway: http://www.ssb.no/english/subjects/09/ur_okonomi_en/.

Although manufacturing has been involved in international trade extensively, the extent of this participation actually differs across industries. Table 2 presents the percentage of firms which export, import and both export and import to the total number of firms in the subsectors of manufacturing classified by the first two digits of industry codes in ISC (2002). From Table 2, we can see that the industries with the highest percent of exporting firms are the industry of paper products, industry of chemical products and industry of communication equipment and apparatus. This condition is consistent with the traditional trade theory that a country is likely to export the products which are relatively intensive in the use of the factor relatively abundant in the country. Norway is a skill-intensive rather than labour-intensive country, and the high share of export in chemical industry and communication equipment industry reflects that the exporting products from Norway are more skill-intensive. While, the high share of export in paper industry may reflect the comparative advantage in the endowment of natural resources used in the paper industry. At the same time, it should be noticed that the ratios of importing firms in these three industries are also among the highest.

From the three columns of numbers, we can see that there are exports and imports in all industries, and firms that both export and import also exist in all industries. If the fact that both export and import exist in the same industry can be explained by the varieties of products in that producers are specialized in certain products, then traditional trade theories cannot explain the simultaneously high percentages of exporting and importing firms in the same industry and the pervasiveness of both export and import in the same firm. However, this can be explained to some extent by the "international fragmentation of production", as in the literature of Bernard *et al.* (2007). As analyzed in their paper, "If some stages of production are undertaken abroad while others occur at home, firms will both import and export". This implies that some of the Norwegian firms import primary products, possibly raw materials and export processed production, for example the ship-building industry.

Table 2: Percent of firms in international trade by manufacturing in Norway

2-digit ISC code Manufacturing	*Percent of firms that export*	*Percent of firms that import*	*Percent of firms that both export & import*
15 Food products and beverages	21	37.5	18
17 Textiles	39	67	36
18 Wearing apparel, dressing and dyeing of fur	30	57	28
19 Leather and leather products	38	67	36
20 Wood and wood products	22	43.5	18.5
21 Pulp, paper and paper products	65	78	60
22 Publishing, printing and reproduction of recorded media	16	31	12
23 Coke, refined petroleum and nuclear fuel	41	46	38
24 Chemicals and chemical products	61.5	80	57.5
25 Rubber and plastic products	56	74	51
26 Other non-metallic mineral products	25	54	22
27 Basic metals	51	68	49
28 Fabricated metal products, machinery and equipment	25	43.5	22
29 Machinery and equipment	33	53	30
30 Office machine and computers	46	67	44
31 Electrical machinery and apparatus	40	61	37
32 Radio, television and communi-cation equipment and apparatus	61	74	59
33 Medical, precision and optical watches and clocks	28	52	27
34 Motor vehicles, trailers and Semi-trailers	49	72	47
35 Other transport equipment	31	52	27
36 Furniture	28	59	25
37 Recycling	33	48	29

Notes:

1) Numbers are computed based on the trade data and employer-employee data from Statistics Norway.
2) The first column is category of industries in manufacturing by 2-digital ISC codes (2002). The second to the fourth columns indicate separately the percent of firms that export, the percent of firms that import and the percent of firms that both export and import, to the total number of firms in each industry.
3) The numbers are mean of annual values from 1996 to 2005.

The opposite direction which means that firms export raw materials or primary products and import technically processed production could also be possible. If we compare the percentages of exporting firms with those of importing firms, it is obvious that the latter significantly exceeds the former. Moreover, this feature is predominant in all of the industries. This fact supports the idea that Norwegian manufacturing has been substantially exposed to the competition from abroad by the import penetration.

3.2 Empirical evidence of firms in International trade

If a firm exports to or imports from other countries, we refer to it as a trading firm and otherwise as a non-trading firm. As described in section 3.1, more than half of the manufacturing firms in Norway trade abroad. This is for the overall sector of manufacturing and it is also true for most of the subsectors displayed in Table 2. Furthermore, among the total trading firms about 48% of them are both exporters and importers. Given the fact that trading and non-trading firms both exist in the market, but they have different decisions on entering international markets or not, are they distinctive from each other? Along what dimensions? And to what extent? Previous studies have investigated why only a part of firms export, and the explanation is that exporting is costly, therefore only the firms which are more productive can cover the costs of entering export markets. Table 3 and Table 8 in Bernard *et al.* (2007) have given some empirical evidence of the exporter premia and trading premia in U.S. manufacturing.

In this chapter, the above questions will be discussed for the Norwegian manufacturing firms by illustrative results from exploiting the data we have. I am going to distinguish the differences between exporters and non-exporters, importers and non-importers, and also the differences between trading and non-trading firms.

3.2.1 Exporters and non-exporters

Following the comparison method in Bernard *et al.* (2007), I use Table 3 to summarize the differences between exporters and non-exporters regarding each

particular firm characteristic. Considering the information available in the data sets and the most distinctive factors of firm characteristics, I choose firm employment size, average wage, capital per worker, value-added per worker and average education of workers as the variables to compare between exporters and non-exporters.

Table 3: Premia of exporters in Norwegian Manufacturing, 2004

	Exporter Premia		
	(1)	*(2)* *Industry fixed effects*	*(3)* *Industry fixed effects & log firm employment control*
Log employment	1.30	1.32	-
Log wage	0.20	0.19	0.07
Log capital per worker	0.23	0.17	0.57
Log value-added per worker	0.28	0.28	0.21
Log mean of workers education level	0.01	0.01	0.01

Notes:
(1) Data resources are from the trade data, employer-employee data and account data of Norway.
(2) Results in the first column of numbers are from the bivariate ordinary least squares regressions with a dummy variable to indicate firm's export status. Regressions in second column of numbers include industry fixed effects besides the binary variables. Regressions in the third column of numbers also include log firm employment as a control variable.
(3) Log wage is the log of the average annual wage in the firm.
(4) All results are significant at the 1 percent level.

All results in Table 3 are from the ordinary least squares regressions with the variables in the first column as dependent variables. All dependent variables are used in log values, so that the coefficients of regressions can be used to interpret the percentage differences. The results in column (1) are from regressions with only the binary variable indicating exporter or non-exporter as explanatory variable. The results establish the advantages that exporters possess compared

with non-exporters. To specify, exporters have 270 percent more employees,[6] 26% more capital per worker, 32% more value-added per worker and pay 22% more to each worker than non-exporters.[7] Moreover, the average education level of workers is also slightly higher in exporters than in non-exporters. The results in column (2) are from regressions including industry fixed effects to control the industrial effects on firms' characteristics in addition to the binary variable. When industry fixed effects are included, there are some changes in the coefficients. The numbers become smaller on the log wage and log capital per worker, but become a little larger on log employment, while there are no obvious changes on the others. Therefore industry characteristics are more correlated with export participation and firm characteristics like employment, wage and capital intensity than with value-add per worker and education level of workers.

Because exporters are relatively larger, in order to avoid that the "exporter premia" just stem from the firm size, log firm employment is also included as a control variable in the regressions of column (3). Under this control, the wage premium paid by exporters is reduced to 7% and premium of value-added per worker reduced to 23%. However, premium of capital per worker increases considerably to 77% which implies that in the same industry and with the same amount of employees, exporters own 77% more in capital per worker than non-exporters. There is no significant difference among the three regressions when it comes to the premium of average worker education level which is reported to be around 1% by all methods. This can probably be explained by that although exporters are more productive and capital-intensive, so more high-educated workers may be in these firms, more low- or medium- educated workers are also needed due to the requirement of the production in manufacturing industries. Therefore, the average education levels in exporters and non-exporters do not differ so much. The findings broadly correspond to the literature in previous

[6] The number is computed by taking exponents of the employment coefficient 1.30 and (exp (1.30)-1)*100=270. Similarly, all premia in the following are calculated in the same way.

[7] The premia presented here are in line with the findings of exporter premium of Norwegian manufacturing firms in "The black box of productivity and the exporter premium" by Irarrazabal, Moxnes and Ulltveit-Moe (2009).

studies from other countries. Exporters own "premia" and the magnitude of the differences between exporters and non-exporters are sizable in manufacturing in Norway.

3.2.2 Importers and non-importers

In both theoretical and empirical studies of international trade on the firm level, attention has been mostly focused on the exporters, probably since they represent the "outstanding ones" and contribute to the growth of productivity. Related to import, both traditional and new theories and empirical works have emphasized the effects of import penetration on the domestic industry and welfare of workers. Very little study has worked on the importing firms individually to investigate their characteristics. In Norway, around 50% of the firms in manufacturing have been importing products, and the annual value of this ratio has been growing consistently from 1996 to 2005. As a result, the number of importers increased by 30% from 1996 to 2005. Among all trading firms, about 94% are importers. While among the importers, only 52% are exporters at the same time. Thus, it is meaningful to make a more thorough study of the importers.

Table 4 exhibits the percentage of firms that import, the percentage of firms that only import among all importers and the percentage of firms that are net importers among all importers by 2-digits industry codes.[8] As evident in the table, the percent of importers varies across industries but imports exist in all industries in manufacturing. The percent of firms that only import also deviates across industries but to a smaller extent. Among these, the ratios of the industry of chemicals and chemical products, industry of radio and communication equipment etc., and industry of paper products are relatively lower. The numbers in the fourth column display that most firms in almost all industries are net importers, except for the industry of radio, television and communication equipment where only 48% of importing firms are net importers.

[8] Net importers are defined as the firms that import more than they export, measured by the values of products.

Table 4: Percentage of firms that import by manufacturing in Norway

2-digit ISC code Manufacturing	*Firms that import*	*Firms that only import in the total importers*	*Firms that are net importers in the total importers*
15 Food products and beverages	37.5	52	78
17 Textiles	67	46	82
18 Wearing apparel, dressing and Dyeing of fur	57	51	90
19 Leather and leather products	67	46	92
20 Wood and wood products	43.5	57	83
21 Pulp, paper and paper products	78	23	71
22 Publishing, printing and reproduction of recorded media	31	61	90
23 Coke, refined petroleum products and nuclear fuel	46	17	55
24 Chemicals and chemical products	80	28	60
25 Rubber and plastic products	74	31	73
26 Other non-metallic mineral products	54	59	88
27 Basic metals	68	28	50
28 Fabricated metal products, except machinery and equipment	43.5	49	76
29 Machinery and equipment	53	43	69
30 Office machine and computers	67	34	56
31 Electrical machinery and apparatus	61	39	72
32 Radio, television and communication equipment and apparatus	74	20	48
33 Medical, precision and optical watches and clocks	52	48	69
34 Motor vehicles, trailers and semi-trailers	72	35	73
35 Other transport equipment	52	48	74
36 Furniture	59	58	86
37 Recycling	48	39	63

Notes:

1) Numbers are computed based on the trade data and employer-employee data from Statistics Norway.
2) The first column is category of industries in manufacturing by the first 2 digits of ISC codes (2002).The second column is the percent of importing firms to the total number of firms in each industry. The third column is the percent of firms that only import to the total number of importers. The fourth column is the percent of firms whose importing values are more than their exporting values (include the firms that only import but do not export) to the total number of importers.
3) All numbers are mean of annual values from 1996 to 2005.

So far, the analysis has given descriptions based on the number of importers. To investigate the characteristics of importing firms, I use the same regression method as used for the exporters. Results are documented in Table 5, where the export premia are also included for comparison. All regressions (except for that of the log employment) have the dependent variables displayed in the first column, and binary variable, industry fixed effects and log employment of firm as covariates. Numbers in column (1) are results for all importers, and numbers in column (2) are results for net importers. Results in the table reflect that importers have similar features as exporters in some of the firm characteristics. Namely, importers have more employees, pay higher wages and generate higher value-added per worker. Nevertheless, the magnitude of those numbers is smaller than the corresponding findings for exporters. There is no significant correlation between import and worker education level, neither do we observe correlation between net import and capital per worker.

The premia of importers listed in column (1) and (2) are the differences between importers (including firms which both import and export) and non-importers (including firms which only export). Hence, it is difficult to distinguish the features of the firms which only import from these numbers. Therefore, I make descriptive regressions separately for the firms which only import and the firms which do not trade. As shown by the results in column (3), firms that only import are larger, more capital-intensive and have higher value-added per worker than the firms which are not trading. The reason why importers also possess premia may be that it is costly to get into the international markets, not only for the firms that export but also for the firms that import. Because of the costs of obtaining information about international markets, the transaction costs and the increased risk, only the larger, more capital intensive and more productive firms can import.

3.2.3 Firms that both export and import

The premia of the firms which are both exporters and importers are displayed in Table 6, with also the premia of all exporters and importers for comparison. All

regressions include binary variable, industry fixed effects and log employment variable (except for the regression with dependent variable of log employment). All coefficients listed in the table are positive and significant at the 1% level. Comparing the results in the three columns of numbers, it is clear that firms which both export and import possess the highest advantages in firm size, wage payment, capital intensity, productivity and composition of workers. With regard to all exporters and importers, exporters own greater premia compared with importers.

Table 5: Premia of importers in Norwegian Manufacturing, 2004

	(1) *Firms that are importers*	*(2)* *Firms that are net importers*	*(3)* *Firms that only import compare with firms that do not trade*	*(4)* *Exporters*
Log employment	1.06	0.50	0.47	1.32
Log wage	0.07	0.04	-	0.07
Log capital per worker	0.30	-	0.13	0.57
Log value-added per worker	0.20	0.11	0.13	0.21
Log mean of workers education level	-	-	-	0.01

Notes:
(1) Data resources are from the trade data and employer-employee data of Norway.
(2) All results are from the ordinary least squares regressions with dependent variable listed in first column and dummy variable to indicate firm's status of export, import or net import. Regressions also include industry fixed effects and log firm employment as control variables. Regressions of log employment don't include log firm employment as interpret variable.
(3) Regressions of first two columns include all firms in manufacturing, while regressions of the column (3) only encompass firms that only import and firms that are not engaged in international trade.
(4) Log wage is the log of the average annual wage in the firm.
(5) All coefficients exhibited in table are significant at the 1 percent level. The results missing in column (1), (2) and (3) which are replaced by "-" are because no significant results observed.

To sum up, the results from the above three classified analyses are broadly consistent with the conclusion in literature: Firm characteristics are systematically related to the participation in international trade, whether export

or import (Bernard *et al.* 2007). Nevertheless, we can ask whether these characteristics exist before firms start to export and import, or whether these characteristics emerge from the participation in international trade. Some theories have been developed to show that the advantages exist even before exporting or importing begins and this is the so-called "self-selection". Only more productive firms are able to overcome the costs of entering international markets. But with regard to the development of trading firms after they get into international markets, there is ambiguous evidence on productivity improvement due to effect of international trade at least in developed countries. By contrast, some empirical works have observed that exporters grow faster in employment and output compared with non-exporters. This probably can be explained to some extent by the expansion of market and demand outside domestic market, and the trade liberalization due to lower tariff or transport costs, and so on.

Table 6: Comparison of exporters, importers and firms that both export and import in Norwegian Manufacturing, 2004

	(1) *Firms that export*	*(2)* *Firms that import*	*(3)* *Firms that both export and import*
Log employment	1.32	1.06	1.45
Log wage	0.07	0.07	0.07
Log capital per worker	0.57	0.30	0.62
Log value-added per worker	0.21	0.20	0.24
Log mean of workers education level	0.01	-	0.01

Notes:

(1) Data resources are from the trade data and employer-employee data of Norway.
(2) All results are from the ordinary least squares regressions with a dummy variable to indicate firm's status of export or import and also industry fixed effects and log firm employment. Regressions of log employment don't include log firm employment as interpret variable.
(3) Log wage is the log of the average annual wage in the firm.
(4) All numbers exhibited in table are significant at the 1 percent level.
(5) The result miss in column (2) which is replaced by "-" is because no significant results observed.

The faster growth of firm size and output in exporters generate reallocation of jobs and workers, as well as output across firms. This has given rise to a number of studies on the effect of reallocation on aggregate productivity growth. In the following part of this paper, I will concentrate on the job reallocation and worker mobility. The motivation for studying these issues is that job and worker reallocations from less productive firms to more productive firms may be a source of the industry productivity growth, and the different patterns of worker mobility of different firms may explain their differences in firm characteristics. Before proceeding to the analysis of empirical results, I briefly present the theories that I shall apply when examine the job reallocation and worker mobility.

4 Theories of gross job flows and labour dynamics

This section explains the concepts of gross job flows and measurement of labour dynamics used in this paper. This theoretical part mainly follows "Gross Job Flows" by Davis and Haltiwanger (1999).

4.1 Gross job flows

When studying gross job flows, I focus on the gross changes of jobs at the sector level. It's useful to see how the concepts are defined.

(1) $JC_{e,s,t} = EMP_{e,s,t} - EMP_{e,s,t-1},\ e \in s^{+}$

Job creation (JC) for firm e in sector s at time t is the net change of employment (EMP) between time $t-1$ and t, if the firm expands or enters between time $t-1$ and t. S^{+} denotes the subset of firms that expand or enter between time $t-1$ and t.

Gross job creation in sector s at time t is

$$C_{s,t} = \sum_{e \in s+} JC_{e,s,t}$$

The gross job creation (C) of sector s is the sum of job creations at the firm level.

(2) $JD_{e,s,t} = |EMP_{e,s,t} - EMP_{e,s,t-1}|,\ e \in s^{-}$

Job destruction (JD) for firm e in sector s is the absolute value of the net change of employment between time t-1 and t, if the firm contracts or exits between time t-1 and t. S^- denotes the subset of firms that contract or exit between time t-1 and t.

Gross job destruction (D) in sector s at time t is

$$D_{s,t} = \sum_{e \in s^-} JD_{e,s,t}$$

The gross job destruction of sector s is the sum of job destructions at the firm level.

(3) $NET_{s,t} = C_{s,t} - D_{s,t}$

Net job growth (NET) is the difference between job creation and job destruction. Therefore, net job growth for sector s is the difference between sectoral gross job creation and sectoral gross job destruction. If net job growth in sector s is positive, employment in this sector grows. In contrast, if net job growth is negative, employment in this sector shrinks.

The rates of gross job flows are consequently the gross job changes divided by the size of total employment. Here, I follow the handbook and use the simple average of employment in t-1 and t for the measure of total employment size:

(4) $Z_{s,t} = \sum_{e \in s} 0.5(EMP_{e,s,t} + EMP_{e,s,t-1})$

The job creation rate, job destruction rate and net job growth rate are defined as follows:

(5) Job creation rate of sector s is $c_{s,t} = \dfrac{Cs,t}{Zs,t}$

(6) Job destruction rate of sector s is $d_{s,t} = \dfrac{Ds,t}{Zs,t}$

(7) Net job growth rate of sector s is $g_{s,t} = \dfrac{NETs,t}{Zs,t}$

Different development of job flows indicate that firms or sectors either experienced expanding or shrinking, unless the changes are zero which then means firms or sectors are stable. This is the indication of job flows on firm and industry level. On the other side, different job changes imply job gains or losses for the employees. Workers are laid off when jobs are reduced, while they are hired when more new jobs are created. These changes of jobs are referred to as job reallocations.

(8) $R_{s,t} = C_{s,t} + D_{s,t}$

(9) Job reallocation rate of sector s at time t is $r_{s,t} = \frac{Rs,t}{Zs,t}$

From equation (8), we can see that job reallocation of sector s is the sum of the sectoral job creation and job destruction. The job reallocation rate is displayed in equation (9).

(10) $X_{s,t} = R_{s,t} - |NET_{s,t}|$

(11) Excess job reallocation rate of sector s at time t is $x_{s,t} = r_{s,t} - |g_{s,t}|$

As displayed by the above equations (10) and (11), excess job reallocation (X) equals job reallocation minus the absolute value of the net job change, and the excess job reallocation rate equals the job reallocation rate minus the absolute value of net job growth rate. Excess job reallocation represents the job reallocation which exceeds the necessary amount of job reallocation for the net employment changes; therefore it indicates the amount of the simultaneous job creations and destructions.

Job reallocation should be distinguished from the reallocation of workers. Worker reallocation at time t is the number of workers who changed their jobs or status of employment between time t-1 and t. Job reallocation must induce worker reallocation, but worker reallocation may not give rise to job reallocation. The changes of workers may be due to job creations or destructions, but it is also possible that they are only caused by the replacement of workers on existing jobs

where job reallocation does not happen. It has been discussed in previous studies that job and worker reallocations across firms within the same sector may be an important channel to increase the productivity at the firm or industry level.[9] In a sense worker reallocation can also be referred to as worker mobility, which is another part of our study in this paper.

4.2 Worker mobility

Workers in a firm at time *t-1* can be divided into two groups by their status at time *t*. One group is the workers who remain in the same firm at time *t* and the other group is the workers who are no longer in the same firm at time *t*. More generally, the workers of the latter group may change to other firms or get out of the labour market temporarily or permanently. The workers who change firms may change to other firms in the same sector or change to other firms in the different sector.

Mobility of workers:

(12) $EMP_{e,s,t-1} = (EMP_{e,s} + EMP_{i,s} + EMP_{g,j} + U)_{t}^{t-1}$

In equation (12), $EMP_{e,s,t-1}$ denotes the total employment of firm e in sector s at time $t-1$. On the right-hand side of the equality sign, the superscript $t-1$ outside bracket denotes that all the workers referred to in this equation are the total employees in firm e at time $t-1$ and the subscript t denotes that the time when the changes are observed is time t. $EMP_{e,s}$, $EMP_{i,s}$, $EMP_{g,j}$ denote respectively the employees that are at the same firm, different firm in the same sector and different firm in different sector. At last, U denotes the part of workers who have left the firm and are out of labour market at time t.

Similarly, we can get the equation of the composition of workers at time t:

[9] For instance, Foster *et al.* (1998) studies the contribution of reallocation to aggregate productivity growth. Balsvik (2006) studies the labor mobility from multinationals (MNEs) to non-MNEs in Norwegian manufacturing and finds that workers who reallocate from MNEs to non-MNEs contribute more to the productivity of non-MNEs.

(13) $EMP_{e,s,t} = (EMP_{e,s} + EMP_{i,s} + EMP_{g,j} + U)_{t-1}^{t}$

Equation (13) decomposes the sources where workers at time *t* are from in terms of time *t-1*. Namely, workers are from the same firm, different firm in the same sector, different sector and those who do not work at time *t-1*. Comparing equations (12) with (13), equation (12) tells us where the workers move to at time *t* as they leave firm *e* and (13) tells us where workers that arrive at firm *e* at time *t* come from.

5 Empirical results on job reallocation and worker mobility in Norway

In this section, I present the results from applying the theoretical principles and concepts set out in section 4 to our data sets. There are two parts in this section which begins with the job reallocation and continues with the worker mobility.

5.1 Job reallocation

The purpose of this section is to describe and compare the changes of jobs in different kinds of firms and to see how the jobs have been reallocated across firms and sectors. The two sectors that I choose to examine are manufacturing and the market service sector. In manufacturing, subsectors of firms grouped by their status in international trade and R&D intensity are examined separately.

5.1.1 Manufacturing and market service sector

As discussed in previous chapters, there have been substantial structural changes in Norway, with the manufacturing sector shrinking and the market service and public sectors expanding. Figure 1 plots the net job growth rates for manufacturing and market service sector from 1996 to 2005. As is evident from the figure, in the period of fast-growing economic years before 1999 net job growth rates are higher in both manufacturing and market service sector. After the year of 1999, economy development slows down and the net job growth rates of both sectors decline to be below zero in most of the years.

Comparing the changes in the two sectors, we can see that net job growth declines even more sharply in manufacturing than in the market service sector. The net job growth rates of manufacturing are lower than that of market service sector in almost all years. This explains why manufacturing has been contracting, while market service sector expands in terms of the share of employment as percent of the whole labour force. Furthermore, this figure displays that these two sectors have some kind of complementary relationship with the job changes. It is quite obvious to notice that when the net job growth rates in manufacturing decline, the net job growth rates in market service sector tend to increase, and vice versa.

Figure 2 displays the picture of job creations and job destructions for manufacturing and market service sector from 1996 to 2005. This figure reveals the details and differences behind the net job changes exhibited in Figure 1. According to the definition in Chapter 4, net job growth is the difference between job creation and job destruction. A lower net job growth rate may be derived from lower job creation rate or from higher job destruction rate or from the combined action of these two effects. Lower job creation rate implies less new jobs created, while higher job destruction rate means more displacement of jobs and workers. Moreover, the higher displacement of jobs may induce more welfare losses to the workers who are separated.

From Figure 2, we can distinguish the characteristics of job creations and job destructions of manufacturing and market service sector. First of all, there are obvious differences in the magnitude of creation rates and destruction rates between them, where both rates are higher in market service sector. Secondly, there are apparent drops in job creation rates for both sectors since 1996. Oppositely, there is not a very evident trend in the changes of job destruction rates, which is especially true for market service sector. The job destruction rates in market service sector are relatively stable across all years. Comparatively, job destruction rates in manufacturing fluctuated more with increasing trend in the late 1990s, but has decreased since 2000. By comparing the changes in job creation and job destruction, we can see that the decrease in net job growth rates

of manufacturing and market service sector in Norway from 1996 to 2005 is mainly driven by the decreasing job creation rates, as job destruction rates varied in a rather smaller range in both sectors. By the uneven development of net job growth, a fraction of jobs have been relocated from manufacturing to market service sector.

Figure 1: Net job growth rates of manufacturing and market service sector in Norway

Figure 2: Job creation and job destruction rates by sector in Norway

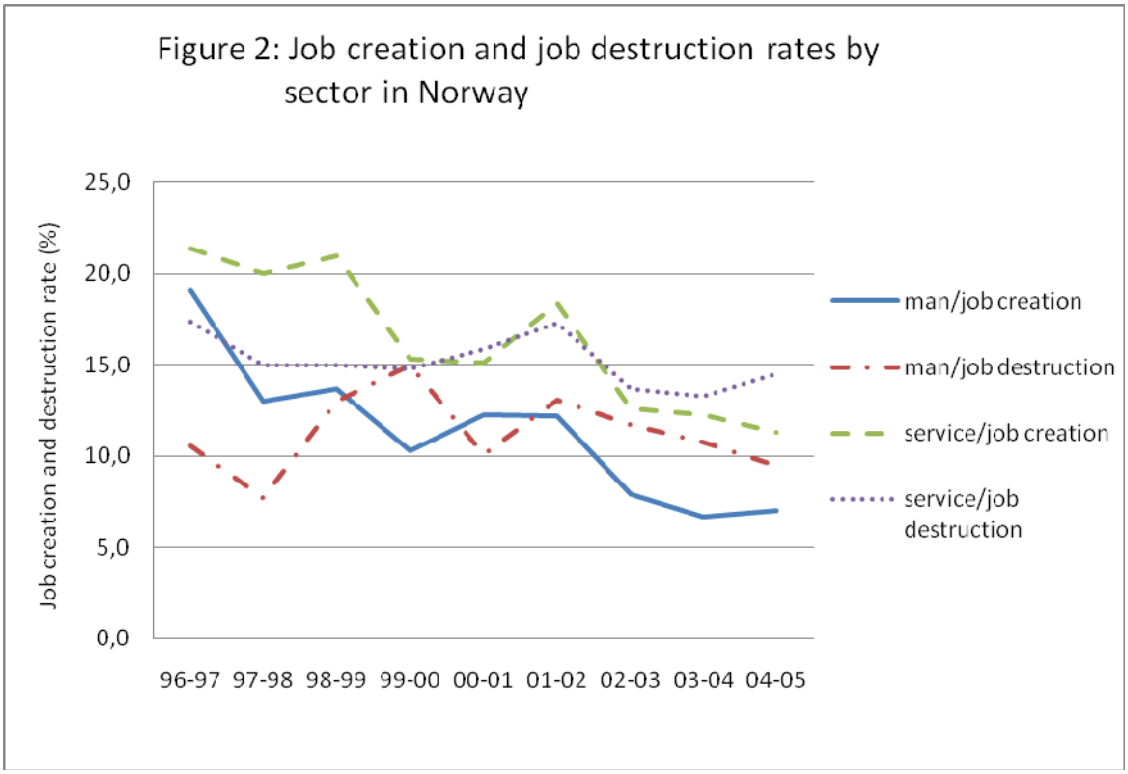
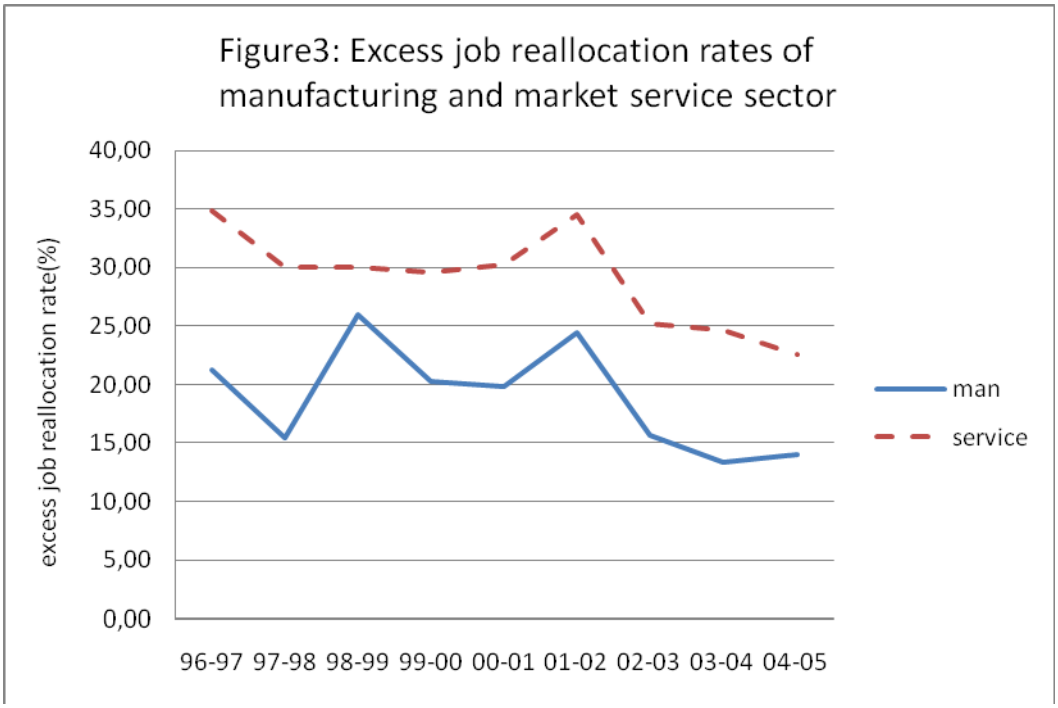


Figure 3 exhibits the excess job reallocation rates in manufacturing and market service sector. The rate of market service sector is significantly higher than that of the manufacturing, but it is interesting that these two sectors have very similar trends in the changes of the graphs. This demonstrates that although there are quite dissimilar changes in the net job growth, job creation and job destruction rates between these two sectors, the difference of the simultaneous job creation and job destruction between them has not been changing very much.



According to their R&D activity levels, industries in manufacturing are divided into two groups, the high R&D-intensive industries and the low R&D-intensive industries.[10] By exploring the net job growth of each group, we find that the development of employment is also different between the industries which are different in R&D intensity. In the group of industries which have comparatively high R&D intensity, the jobs have been growing by an annual rate of 1.7%. The total number of employees worked in these industries increased by

[10] Here, we use the R&D personnel number at the industry-level as the standard for classification. Details about the R&D classification of industries can be found in the appendix.

around 20% from 1996 to 2005. In contrast, the group of low R&D-intensive industries has experienced shrinking of jobs by an average annual rate of 0.4%.

5.1.2 Traders and non-traders in manufacturing

In this section, I study the job flows for the manufacturing sector by segmentation of exporters, non-exporters, importers and non-traders.[11] By this separation, we aim to explore their differences in job development and further to investigate the job reallocation between the subsectors in manufacturing according to firm's status in international trade. Moreover, the firms in the exporter subsector and non-exporter subsector are further distinguished in terms of their R&D intensity.[12] By this, we aim to explore if there are different patterns of job flows in different R&D-intensive firms, even after we have controlled firms' status with respect to exporter and non-exporter.

Figure 4 illustrates the development of net job growth of the subsectors in manufacturing. By a close look at the graph, it is evident that exporters and importers have quite similar directions of changes, especially before 2000. In contrast, non-exporters and non-traders show dissimilar and more diverse changes compared with exporters and importers, and there is not much resemblance between themselves either. Generally speaking, exporters and importers are relatively stable, compared with non-exporters and non-traders which fluctuate much more and with more obvious downward slope in the graph. The difference in fluctuation can be confirmed by the standard deviation of net job growth rate, which is 0.045 for exporters and importers, 0.084 for non-exporters and 0.095 for non-traders. On average, exporters and importers have experienced a growth of jobs by an annual rate of 0.9% from 1996 to 2005. On the

[11] Exporters are firms that have export with positive values during the year when job growth is observed. Importers are firms that have import with positive values during the year when job growth is observed. Non-traders are firms that neither export nor import. There are overlaps between exporters and importers which are known as the firms that both export and import. Non-exporters include non-traders and the firms which only import.

[12] As R&D-intensity is distinguished at the industry-level, thus the firms in R&**D**-intensive industries are classified as R&D-intensive firms and firms in low-R&D-intensity industries are defined to be firms with lower R&D-intensity. For simplicity, exporters in the R&D-intensive industries are referred as R&D-intensive exporters. Of course, this standard is not precise.

contrary, non-exporters and non-traders have negative growth with a rate of −1.8% on average each year. In another way, averagely there are 1755 new jobs increased in exporters, while 1635 jobs lost in non-exporters each year. Or, 1145 new jobs increased in traders and 1025 jobs lost in non-traders each year on average.[13]

Net job growth of exporters and non-exporters in manufacturing by R&D intensity are plotted in Figure 5. From the graph, we can see that high R&D-intensive exporters and low R&D-intensive exporters have relatively similar trends in changes. Conversely, the changes of high R&D-intensive non-exporters and the changes of low R&D-intensive non-exporters differ from each other greatly. Among all groups, the high R&D-intensive exporters have the highest net job growth rate and the low R&D-intensive non-exporters have the lowest net job growth rate. Meanwhile, the fluctuations of these two groups are also greater than the other two groups. By the average of the annual values of their net job growth rates, high R&D-intensive exporters have grown by around 2% each year; low R&D-intensive exporters and high R&D-intensive non-exporters have similar increases of 0.4% and 0.2% separately each year; but low R&D-intensive non-exporters have experienced contraction by an annual net job growth rate of –2%. The results illuminate the fact that there has been a considerable amount of jobs relocated within manufacturing, from non-exporters to exporters and from low R&D-intensive firms to high R&D-intensive firms during the years from 1996 to 2005.

When I compute the job changes from year $t\text{-}1$ to year t, I calculate the net changes between the number of workers in the beginning of year $t\text{-}1$ and the number of workers in the beginning of year t for a specified sector. Therefore, the standard to classify exporters and non-exporters and similarly to other categories is whether there is exporting or importing in the firms during the year $t\text{-}1$. From 1996 to 2005, our observations in the data of exporters in manufacturing are 7318

[13] Comparatively, the results in OECD studies reported that "Over the period 1994-2004, there is a small negative correlation of -0.19 in OECD economies between greater openness and changes in employment rates." (OECD Economic Studies No.44,2008/1)

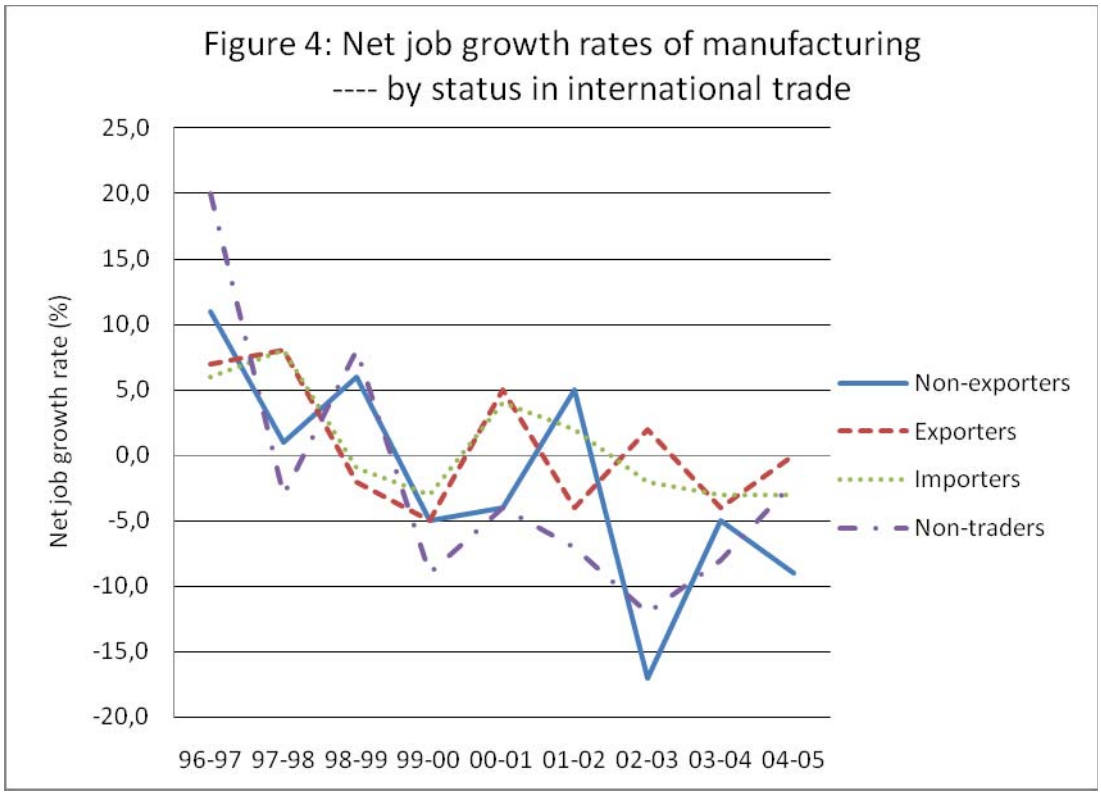


Figure 4: Net job growth rates of manufacturing
---- by status in international trade
Net job growth rate (%)
25,0
20,0
15,0
10,0
5,0
0,0
-5,0
-10,0
-15,0
-20,0
96-97 97-98 98-99 99-00 00-01 01-02 02-03 03-04 04-05
Non-exporters
Exporters
Importers
Non-traders

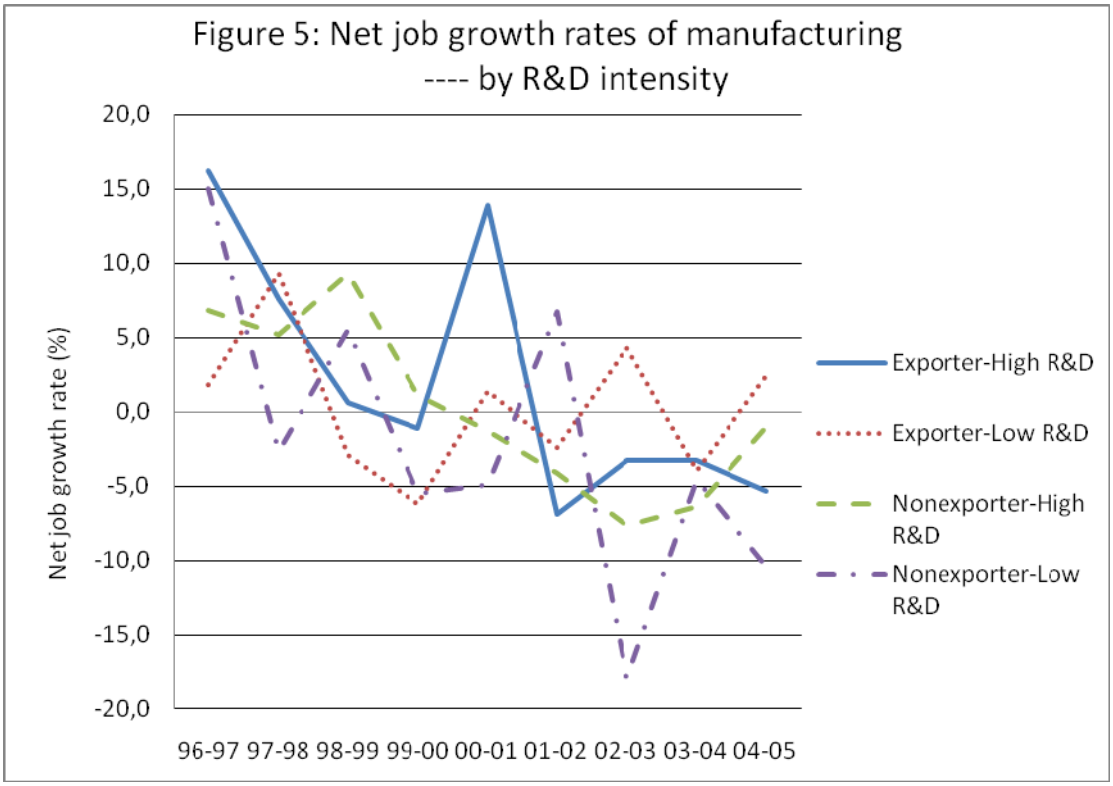


Figure 5: Net job growth rates of manufacturing
---- by R&D intensity
Net job growth rate (%)
20,0
15,0
10,0
5,0
0,0
-5,0
-10,0
-15,0
-20,0
96-97 97-98 98-99 99-00 00-01 01-02 02-03 03-04 04-05
Exporter-High R&D
Exporter-Low R&D
Nonexporter-High R&D
Nonexporter-Low R&D

firms in total and around 3060 firms each year on average. Among all exporters each year, about 78% of them are exporters at least in two continual years, say *t-1* and *t*. Across all the observation years, only 16% of total exporters have been stable with their exporting for ten years. By looking at the status in serial years, we can decompose the exporters into details. Besides the firms that are stable with the status of exporter across year *t-1* and *t*, there are new entering firms, exiting firms, and firms that change between exporters and non-exporters in the observed serial years. In terms of the percentages of the number of firms each year, about 4% are new entrants, 6% exit, 78% are still exporters in the next year, 77% are also exporters in the last year and 16% change from exporters to non-exporters and 19% are firms that changed from non-exporters to exporters between year *t-1* and year *t*.[14]

Based on this decomposition, we are able to examine the job flows in more detail. Here, I look at the subsector of exporters. As displayed in Table 7, sectoral net job growth rates in column (1) are decomposed into the contributions of net entry, growth of stable exporters and the changes from non-stable exporters. It is evident from the numbers in column (2) that the contribution of net entry is always non-negative and mostly is positive across all the years. This simply reveals that exiting exporters are smaller than entering exporters in the size of employment, which can be confirmed by the percentages of firms.[15] If firm size is positively correlated with productivity, then this result can be explained that less productive firms exit from the export markets and more productive firms enter the export markets.

Column (3) exhibits the contribution stemming from the job changes of the firms which are exporters in two continual years. This part accounts about 78% of the firms and 90% of the employment in all exporters. Therefore, most exporters are relatively stable with the status of exporting. But the net job

[14] The total number of exporters in year *t-1* = stable exporters + exit exporters + exporters change to non-exporters in year *t*, while total exporters in year *t* = stable exporters + entry exporters + exporters changed from non-exporters of year *t-1*.

[15] The percents of the firms to the total exporters are 6% for exiting exporters, and 4% for entering exporters which implies more exporters exit than enter averagely each year.

growth is negative in this group with a rate of –2% each year on average. From column (4) and (5), we can see the percentage of employment in the firms that transfer between exporters and non-exporters across two sequential years. On average, 19% of all exporters in year *t* changed from non-exporters in year *t-1*, while 16% of exporters in year *t-1* change to be non-exporters in year *t*. By number of employees, the firms which change from non-exporters account for 7.9% of total employment in the exporter subsector each year and the firms which change from exporters to non-exporters account for 6.4% averagely. Numbers in column (4) and (5) of Table 7 confirm further that not only the average number of employment in firms that change from non-exporters to exporters is greater than that in firms that change from exporters to non-exporters, but also the value in every individual year is in this pattern (except 1996 and 2001).

From the above evidence, it seems that relatively stable exporters are larger in firm size than the exporters changing status and also larger than the exporters that exit or just enter the export markets, while entering exporters are larger than exiting exporters averagely. Moreover, the new entrants and stable exporters are more productive than the others. This has been confirmed by regressions with log value-added per worker as dependent variable and the dummy variable indicating status of firms in export as interpret variable. The coefficients of the dummy variable for stable exporters and new entering exporters are significantly positive and higher than the coefficients of the dummy variables for exiting and changing exporters across all the years from 1996 to 2005.[16] This outcome is corresponding to the theory of "self-selection" once again: only more productive firms can enter and survive in the export markets.

Returning to job growth, by the decomposition in Table 7, it is easy to notice that the positive net job growth in the exporter subsector is attributed to the positive job growth in net entries and net transfers (the disparity between changing exporters) but not to the expansion of stable exporters. On the contrary,

[16] The coefficients of dummy variables for stable exporters and entering exporters are significant across all years from 1996 to 2005, yet the coefficients for exiting and changing exporters are not significant in all years.

Table 7: Decomposition of net job growth of exporters in manufacturing

Year	(1) Net Growth of exporter sector	(2) Net Entry	(3) Net Growth of Stable Exporters	(4) Percent of jobs (Exp. to Nonexp.)	(5) Percent of jobs (Nonexp. to Exp.)
96-97	0.070	0.016	0.066	-0.100	0.089
97-98	0.075	0.005	0.042	-0.056	0.083
98-99	-0.019	0.015	-0.043	-0.092	0.101
99-00	-0.047	0.015	-0.083	-0.060	0.081
00-01	0.054	0.006	0.030	-0.047	0.065
01-02	-0.038	0.047	-0.059	-0.099	0.072
02-03	0.020	0.000	-0.041	-0.036	0.096
03-04	-0.038	0.008	-0.050	-0.048	0.052
04-05	0.001	0.002	-0.029	-0.040	0.068
Mean	0.009	0.013	-0.019	-0.064	0.079

Notes:
(a) The numbers in the first column present the changes from year *t-1* to year *t*.
(b) In column (1) are the net job growth rates of total exporter sector. Column (2) presents the job growth rates contributed by net entry. Column (3) is the net job growth rate by the stable exporters which are defined as the firms that are exporters in both year *t-1* and year *t*. Column (4) is the percent of jobs from the firms which change status from exporters to non-exporters across year *t-1* and *t*. As this part is deducted from the group of exporters, these numbers are taken as negative. Last column (5) is the percent of jobs from the firms that change from non-exporters to exporters, thus the numbers are positive.
(c) The numbers in the last row are the mean of annual values.

there is a decrease of jobs in the sector of stable exporters by the rate of 2% averagely each year. This has to be compared with the net job growth among changing firms. The group of firms that change from exporters to non-exporters from year *t-1* to year *t* experiences contraction during year *t-1*, while the group of firms that change from non-exporters to exporters from year *t-1* to year *t* has been growing. The magnitude of contraction and growth every year is 7% and 2% of the size of each group on average. Therefore, stable exporters experience shrinking but the magnitude is much smaller than that of the exporters which was changing to be non-exporters.

Changes in firm size are usually correlated with the development of a firm's production, productivity, competitiveness and so on. On one side, firms with higher productivity get into export markets and replace the firms which are less competitive. The higher the productivity an exporter has, the longer it can stay in export markets. Nevertheless, there are always new exporters that arrive with even greater advantages than what existing exporters have. On the other, the changes in firms' performance may explain partly the reason for firms' transfers between exporters and non-exporters. When firms grow fast and get the ability to cover the costs, they have willingness to get into the international markets.[17] While when firms encounter problems in their development that are likely to be reflected in the contracting of employment, they will be forced to or voluntarily withdraw from the export markets.

Behind the changes in the size of the groups, are the reallocations of jobs and workers across the firms. In a sense, international trade induces more reallocations of input and output across sectors and producers, due to more intensive competition from export markets or import penetration. In the literature and empirical research, reallocation across individual producers within the same industry is connected to the aggregate productivity growth. The destructions incurred from exiting or down-sizing firms are so-called "creative destruction" (Schumpeter, 1942). But just as Huttunen, Møen and Salvanes (2003) said "such reallocation is not frictionless" and there are particular costs to the workers who are displaced due to firms' exits or contraction.

The issue of the role of reallocation in contributing to aggregate productivity growth has attracted much attention in empirical research in some countries. However, the testing of this relationship requires prudence. As Foster *et al.* (1998) summarizes "large productivity differentials and substantial reallocation are the necessary ingredients for an important role for reallocation in aggregate productivity growth". It is also stated that the existing studies yield a wide range of findings regarding the contribution of reallocation to aggregate productivity

[17] In the study of Alvarez and López (2005) for Chilean plants, they find the "self-selection" is a conscious process in the sense that plants increase productivity with the purpose of becoming exporters.

growth.[18] This paper does not investigate explicitly the role of reallocation in aggregate productivity growth, but studies the composition of labour force with respect to workers' education level in each kind of firms, and also studies the mobility and reallocation of workers. Improvement in the composition of labour force is positively correlated with technical upgrading and productivity growth, and the composition of labour force is linked to firm characteristics. The reallocation of workers with different skill levels may have influence on individual firm's growth and also on the aggregate productivity growth. I process these studies for workers in different manufacturing firms, distinguished according to their status in exporting and R&D intensity. The composition of workforce and the labour mobility in market service sector have also been investigated. Hence, we will not only study the labour reallocations within manufacturing, but also study the labour reallocations between manufacturing and market service sector. The outcomes from exploiting our data are presented in the following section.

5.2 Worker mobility

I study the mobility of workers by investigating where the workers from year $t-1$ are in year t. All workers are divided into three groups by low, medium and high education level. Low-educated group includes the workers with education up to 10 years and the workers with unspecified education information. Medium-educated group are workers with education of 11 to 14 years. And, high-educated means those with education of 15 and more years. According to the standard of Norwegian education system, workers with low education level are those who only accomplish compulsory education. Medium education level corresponds to intermediate education with upper secondary and post-secondary but non-tertiary education. High education level is the tertiary education.

[18] Ekholm, Moxnes and Ulltveit-Moe (2009) find that the aggregate productivity growth of Norwegian manufacturing from 1996-2004 is mainly attributed to the within-firm improvement. The reallocations between firms and exits play a less important role in the productivity increase.

In the study of this section, I only include the full-time workers which are recorded as working 30 hours or more per week. Also, I only include the work experience of three months or more for each worker at each job position.

5.2.1 Composition of workforce

The composition of workers with different education level varies across industries. The differences between them are exhibited in Table 8 with the share of workers with different education level to the total number of workers in each sector or subsector.

From the numbers in Table 8, we can see that the medium-educated workers are the main force in the labour composition, and the shares of these workers are not significantly different across all the groups of different firms. However, the shares of low-educated and high-educated workers display rather differently in different groups. First, the share of high-educated workers in the whole manufacturing is significantly lower than that in market service sector. Second, the shares of low-educated and high-educated workers differ markedly across the subsectors within manufacturing. The most notable feature is that firms in high R&D-intensive industries have a distinctively larger share of high-educated workers and consequently have a lower share of low-educated workers. But this feature is not surprising, as high R&D-intensive industries are relatively intensive in skills and the R&D activities are mainly carried out by high-educated personnel. Exporters also have larger share of high-educated workers compared with non-exporters. This is consistent with that exporters are more productive and more skill-intensive.

In the following, I study the dynamics of the labour force composition. Firstly, I examine the changes in manufacturing and market service sector with Figure 6 and Figure 7. Variations in the graphs indicate that the share of high-educated workers has been continuously increasing, and the share of low-educated workers has been continuously decreasing, in both sectors from 1996 to 2004. The share of medium-educated workers in market service sector also has decreased, but the share of medium-educated workers in manufacturing has increased. The

composition of the workforce in high R&D-intensive industries is illustrated with Figure 8. The most obvious difference in this figure is that the share of high-educated workers exceeds the share of low-educated workers since 1998, and the dispersion between them gets larger and larger afterwards.

Table 8: Comparison of labour composition–by status in export and R&D intensity

Sector	Education Level		
	1	*2*	*3*
Market service sector	0.23	0.53	0.24
Manufacturing	0.29	0.55	0.16
Exporters in manufacturing	0.28	0.55	0.17
Non-exporters in manufacturing	0.31	0.56	0.13
High R&D- intensive industries in manufacturing	0.22	0.53	0.25
High R&D- intensive exporters in manufacturing	0.21	0.52	0.27

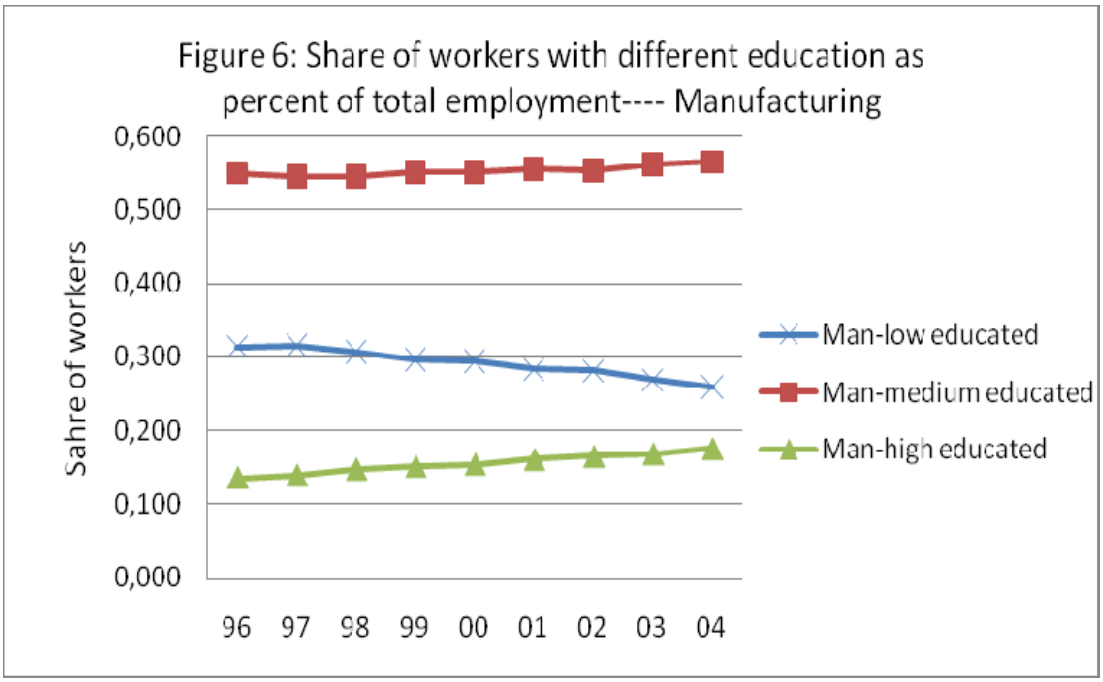
Notes:

(1) Numbers of workers are accounted from the employer-employee data. All workers accounted are full-time workers and worked at least 3 months in a given job position.

(2) Exporters and non-exporters are the firms that hold the status of exporter or non-exporter at least for two serial years.

(3) Numbers in table are the simple average of annual values from 1996 to 2005.

(4) *1*= low educated, *2*=medium educated, *3*= High educated.



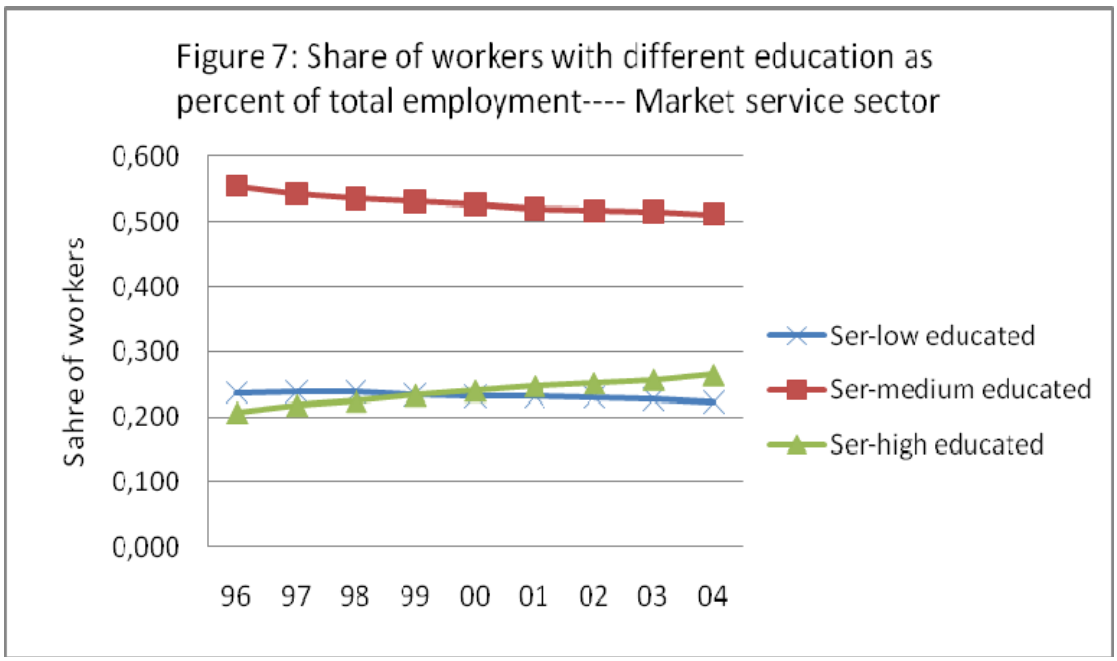


Figure 7: Share of workers with different education as percent of total employment---- Market service sector
Sahre of workers
0,600
0,500
0,400
0,300
0,200
0,100
0,000
96 97 98 99 00 01 02 03 04
Ser-low educated
Ser-medium educated
Ser-high educated

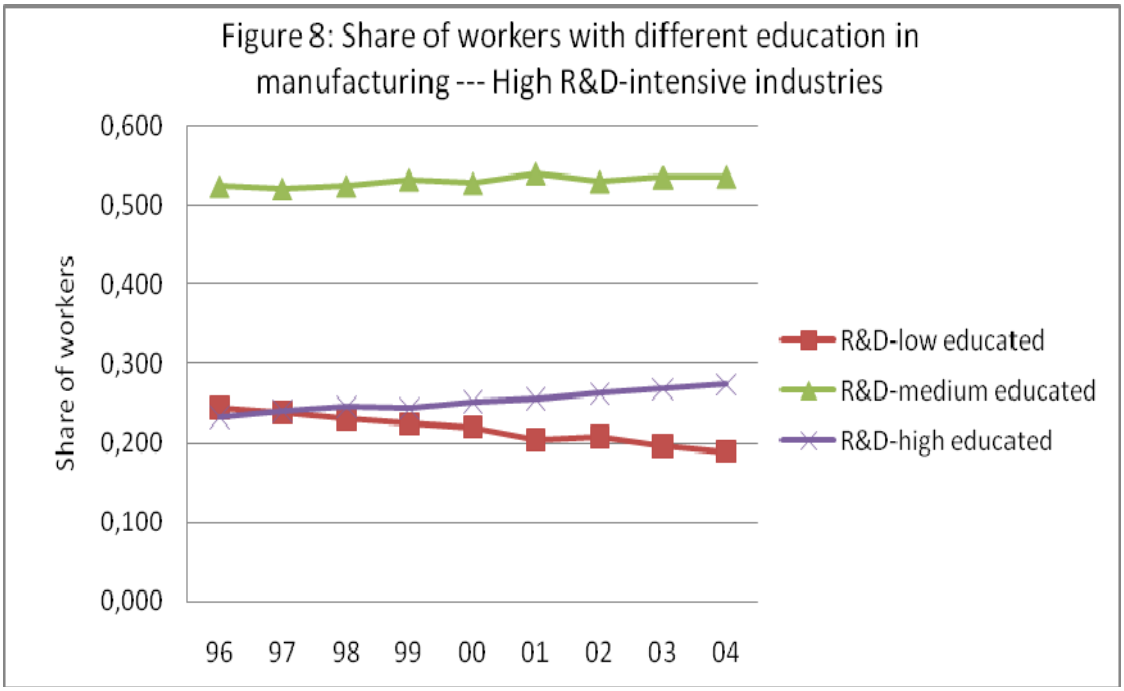
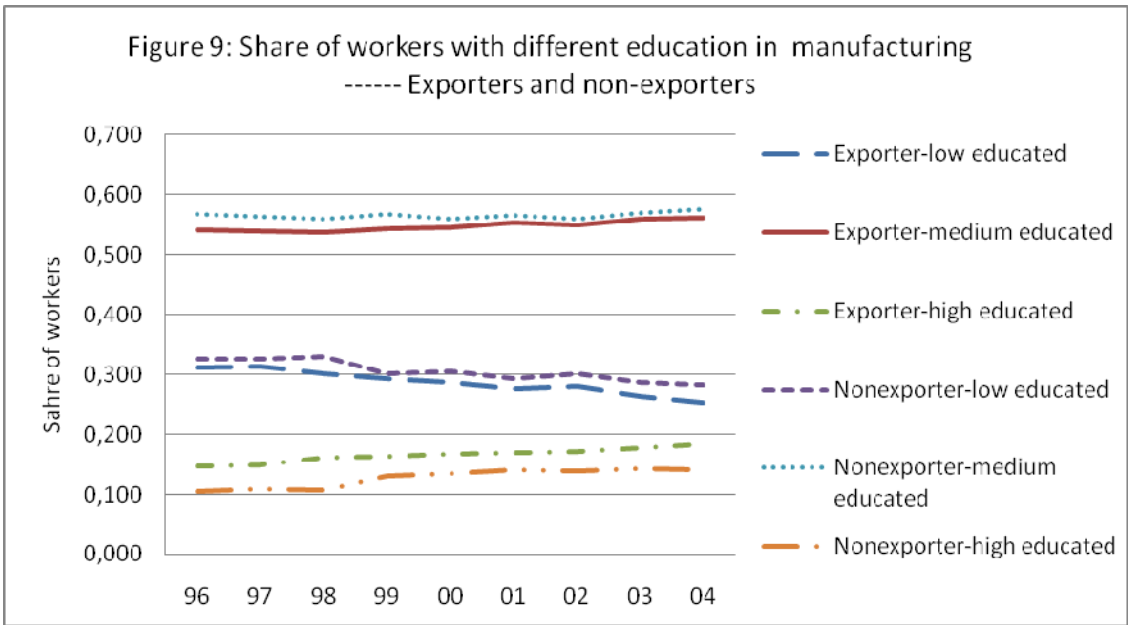


Figure 8: Share of workers with different education in manufacturing --- High R&D-intensive industries
Share of workers
0,600
0,500
0,400
0,300
0,200
0,100
0,000
96 97 98 99 00 01 02 03 04
R&D-low educated
R&D-medium educated
R&D-high educated

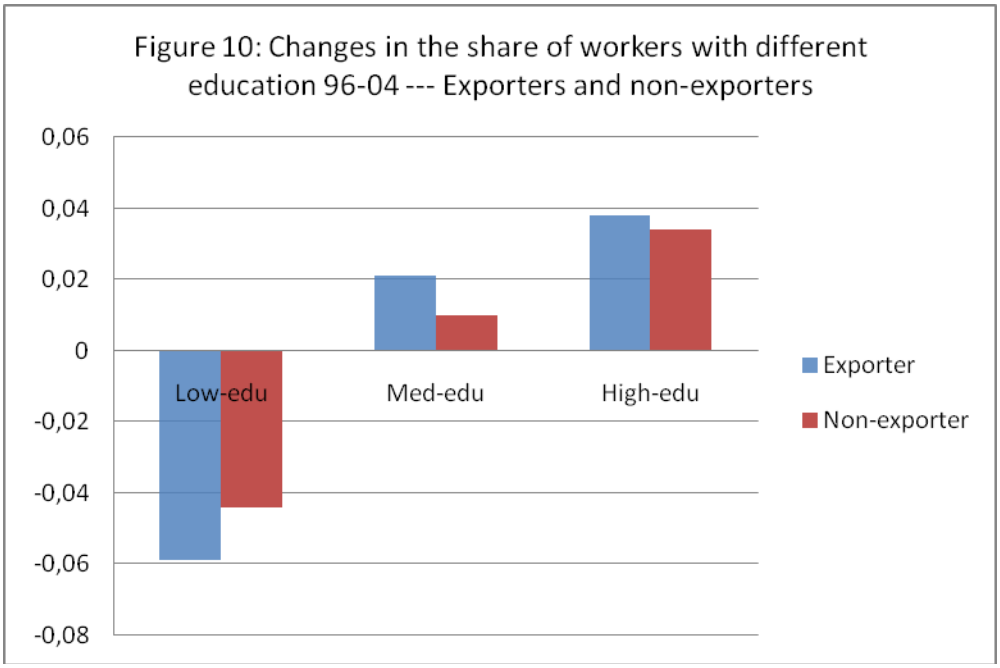
Figure 9 presents the employment compositions of exporters and non-exporters in manufacturing.[19] There is no significant difference in terms of the changing patterns between them. Nevertheless, exporters have larger share of high-educated and smaller share of low-educated workers than non-exporters across all the years. The increases of the share of high-educated workers and the decreases of the share of low-educated workers are both relatively faster in exporters than in non-exporters. As a result, the difference between the shares of low- and high-educated workers in exporters becomes much smaller than that in non-exporters when it gets to 2004.



If the difference of the changes in the share of workers between exporters and non-exporters is not shown obviously in Figure 9, then it is better exhibited in Figure 10. The columns display the magnitude of the changes in the share of workers between 1996 and 2004 for exporters and non-exporters. From the differences in the height of the columns in each education level, we can see that the shares of the medium-educated and high-educated workers in exporters both increase faster than those in non-exporters, and the difference in the increases of

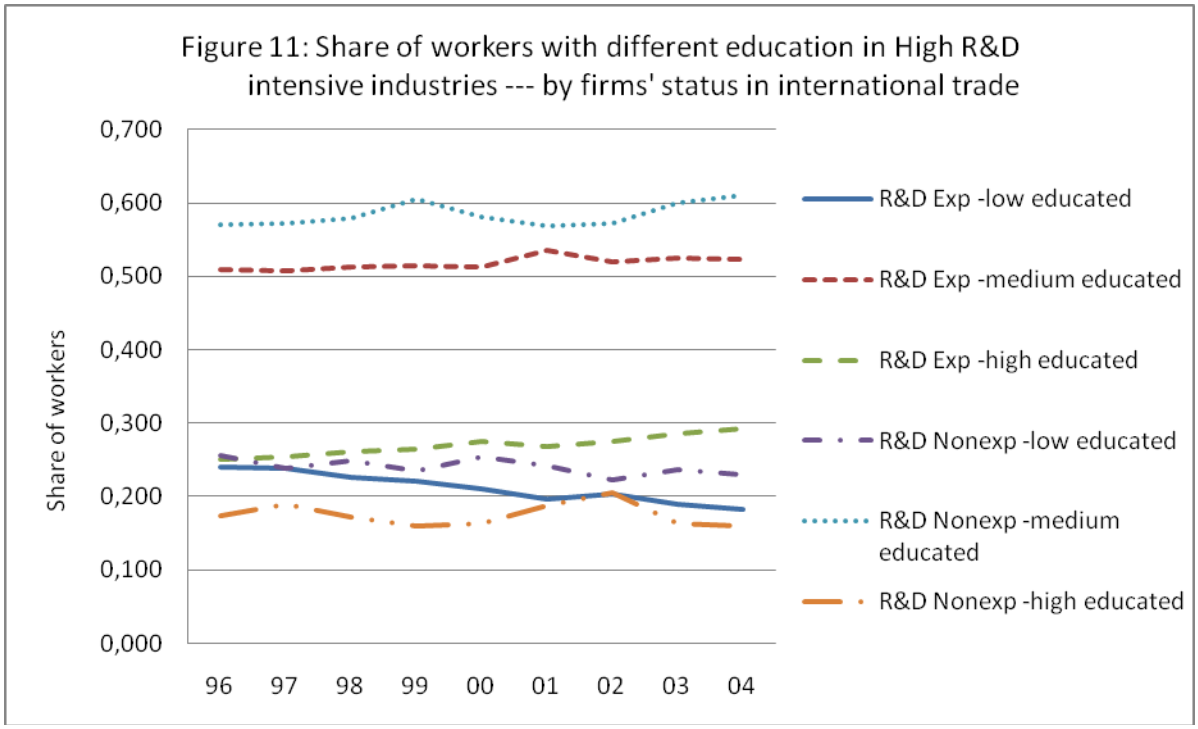
[19] The exporters and non-exporters are the firms that hold the status of exporter or non-exporter at least in two serial years. Therefore, the years shown in Figure 9 are from 1996 to 2004. For consistency and comparison, other figures of labour composition are also plotted for the years from 1996 to 2004.

the share of medium-educated workers is particularly large, whereas the difference of the growth in the share of high-educated workers is less remarkable.



When the employment composition and their dynamics are compared between exporters and non-exporters within the high R&D-intensive industries, some obvious differences between them can be found, as shown in Figure 11. For example, there have been persistent increases in the share of high-educated workers and decreases in the share of low-educated workers in exporters. But the rates of the workers with different education level fluctuated much more in non-exporters. Also, the differences of the employment composition between exporters and non-exporters are greater in high R&D-intensive industries than in the whole manufacturing. The reasons might be that the high R&D-intensive industries are more technology-intensive, so R&D and knowledge activity are more crucial in improving firms' competitiveness.[20] Thus, the composition of labour force in exporting firms differs greatly from that of the firms which do not export in high R&D-intensive industries.

[20] From the paper by Pires (2007), firms with a first-mover advantage in R&D have higher competitiveness levels, and as a result they also have better access to export markets.



There are two implications of the employment patterns which are needed to be highlighted. As discussed earlier, employment pattern is related with firm characteristic. The production in a particular firm determines this firm's employment, while employment in turn affects firm's development. More skilled workers are required in the exporting firms and high R&D-intensive firms due to the nature of their production and the demand for improvement in technology, productivity and competitiveness in international and domestic markets. The employment of more skilled workers supports the growth of exporters and high R&D-intensive firms, consequently more skill-biased jobs will be generated in these firms, and therefore, there will be the reallocations of skilled workers from non-exporters and low R&D-intensive firms to exporters and high R&D-intensive firms. To learn more about the worker reallocation, I investigate the mobility of workers in the following of this paper.

5.2.2 Mobility of workers

The mobility of workers is studied for manufacturing and also for market service sector in Norway for the years from 1996 to 2005. In the studies for manufacturing, the mobility of workers in high R&D-intensive industries and the

mobility of workers in exporters and non-exporters are studied separately. Furthermore, I also investigate the mobility of workers in the exporters of high R&D-intensive industries in manufacturing. The rates of stable workers, mobile workers and the directions of their movement are observed by exploiting our data.

First of all, we compare the mobility of workers in manufacturing with that in market service sector by Table 9 and Table 10. The first part of each table is the average number of workers that were employed in that sector in year *t-1*, the percent of workers who stayed in the same firm in the following year *t* and the percent of workers who were not staying in the same firm in year *t*. From this part, we can see that the stability of workers in manufacturing is greater than that in market service sector and the stability increases with education level. The second point is more evident in market service sector, while in manufacturing the stability of high-educated workers is lower than the stability of medium-educated workers but much higher than that of low-educated workers. The second part of each table is the directions where the unstable workers have moved to in year *t*. The rows numbered from 1 to 3 are the places where the movers get a new job. The rows numbered 4 indicate the share of movers who are not found in the labour market in year *t*.[21]

Among the workers who moved to new firms, most of them still work in the same sector as in the year before. This corresponds to the results found in previous studies that most reallocations of workers are inter-firms and intra-sectors.[22] By examining the share in each direction, it can be found that the share of the movers reallocated from manufacturing to market service sector is much higher than the share of movers reallocated from market service sector to manufacturing. On average, there are 5700 more workers reallocated from manufacturing to market service sector than from market service sector to

[21] The results on worker mobility and the share of workers are not found in the labor market in this section have the possibility to be overestimated in that work experiences with less than 3 months are eliminated from our data.

[22] For reference, see Salvanes and Førre (2001).

manufacturing each year. Besides the intra-sector reallocations and between manufacturing and market service sector reallocations, some workers move to other sectors, for example public sector or agriculture. All other sectors are summarized in rows numbered 3. Except for those movers counted in the rows from 1 to 3, the other movers which are counted in the rows numbered 4 are not found in our data in the next year. This implies that those workers may get out of the labour market voluntarily or involuntarily at least for one year. Shares of these workers are smaller in market service sector and decrease substantially with education level in both manufacturing and market service sector. Therefore, workers who leave their last jobs in market service sector and workers with higher education level can relatively easier get new jobs.

Table 9: Mobility of workers in market service sector in Norway

		Education		
	All	1	2	3
Total workers	*562,835*	*131,052*	*296,976*	*134,807*
Stable workers	*0.726*	*0.691*	*0.735*	*0.741*
Movers	*0.274*	*0.309*	*0.265*	*0.259*
Direction of movement				
1. Other firms in market service sector	*0.445*	*0.394*	*0.451*	*0.493*
2. Manufacturing	*0.053*	*0.053*	*0.054*	*0.051*
3. Other sectors	*0.093*	*0.076*	*0.086*	*0.122*
4. Others	*0.409*	*0.477*	*0.409*	*0.334*
Total movers (=100 %)	*154,144*	*40,566*	*78,795*	*34,783*

Notes: (1) All numbers are mean of annual values from 1996 to 2005.
(2) 1= low-educated, 2=medium-educated, 3=high-educated.

In the market service sector, workers with low and medium education levels more likely change to manufacturing compared with the high-educated. The percent of medium-educated workers who changed to manufacturing is slightly higher than that of low-educated. By contrary, in manufacturing the percent of workers who moved to market service sector increases substantially with education level, and the percent of high-educated workers moved to market service sector is particularly sizable. This feature of the reallocations between

manufacturing and market service sector reveals the different requirement on the skill level of the labour force in the two sectors, and this feature of reallocation is also consistent with their characteristics in the composition of workforce. Through the larger extent in the displacement of low-educated workers displayed in the rows numbered 4, the upgrading of labour force composition proceeded in both manufacturing and market service sector.

Table 10: Mobility of workers in manufacturing in Norway

		Education		
	All	1	2	3
Total workers	*250,075*	*72,874*	*138,342*	*38,859*
Stable workers	*0.790*	*0.770*	*0.799*	*0.792*
Movers	*0.210*	*0.230*	*0.201*	*0.208*
Direction of movement				
1. Other firms in manufacturing	*0.308*	*0.269*	*0.332*	*0.311*
2. Market service sector	*0.142*	*0.113*	*0.138*	*0.213*
3. Other sectors	*0.082*	*0.065*	*0.087*	*0.098*
4. Others	*0.468*	*0.553*	*0.443*	*0.378*
Total movers (=100 %)	*52,945*	*16,891*	*27,982*	*8,072*

Notes: (1) All numbers are mean of annual values from 1996 to 2005.
(2) 1= low-educated, 2=medium-educated, 3=high-educated.

Table 11: Mobility of workers in high R&D-intensive industries of manufacturing

		Education		
	All	1	2	3
Total workers	*63,755*	*13,793*	*33,825*	*16,137*
Stable workers	*0.797*	*0.784*	*0.800*	*0.800*
Movers	*0.203*	*0.216*	*0.200*	*0.200*
Direction of movement				
1. Other firms in manufacturing	*0.362*	*0.321*	*0.378*	*0.350*
2. Market service sector	*0.152*	*0.117*	*0.142*	*0.213*
3. Other sectors	*0.081*	*0.061*	*0.086*	*0.077*
4. Others	*0.405*	*0.501*	*0.394*	*0.360*
Total movers (=100%)	*12,972*	*2,980*	*6,765*	*3,227*

Notes: (1) All numbers are mean of annual values from 1996 to 2005.
(2) 1= low-educated, 2=medium-educated, 3=high-educated.

The mobility and reallocation of workers in the high R&D-intensive industries of manufacturing are exhibited above in Table 11. Compared with the whole manufacturing, there is no significant difference in the stability of workers from these industries, but the share of worker reallocation within manufacturing is higher. The share of movers that still stay in manufacturing is around 31% in the whole manufacturing and 36% in high R&D-intensive industries. Moreover, the differences among the differently educated workers are comparatively smaller in high R&D-intensive industries. This illustrates that, although the workers have different education levels, "learning-by-experience on job" reduced the differences in their skills and therefore reduced the differences in their choices of jobs.

Next, I study the mobility of the workers in exporters and non-exporters in manufacturing. Similarly, I use Table 12 and Table 13 to present the results. Additionally, to investigate especially whether there are differences in the worker mobility and reallocation patterns of the exporters in high R&D-intensive industries, I study them separately and display the results in Table 14. Firstly, by comparing the stability of workers in exporters and non-exporters, we can notice that workers in exporters are much more stable than those in non-exporters. On average, 84% of total workers in exporters are found in the same firm next year but this number for non-exporters is only about 71%. Stability is generally increasing with education level, but the stability of high-educated workers is lower than that of medium-educated workers in exporters. It should be noted that the lower stability of high-educated workers in exporters is mainly caused by the higher share of movers changed to market service sector. There is no significant difference in the rates of stability and mobility in high R&D-intensive exporters. Secondly, by analyzing the percentages of workers who moved to different directions, we can see that more than half of the moving workers moved to a new job, and there is no significant difference with this percentage between exporters and non-exporters. But this percentage is relatively higher in high R&D-intensive exporters.

Among the workers who find a new job in the next year, most of them still stay in manufacturing. This is seen from the percent of movers who find a new job in

other firms in manufacturing to the total number of movers who are still in labour market in the next year. This percentage is 51% for exporters, 55% for high R&D-intensive exporters and 56% for non-exporters. The firms where most workers (both from exporters and non-exporters) reallocate to are the exporters in manufacturing. The most outstanding difference in high R&D-intensive exporters is that the share of workers who reallocated within exporters is remarkably higher.

This demonstrates once again that most reallocations are within sectors and from less productive to more productive establishments. This is also consistent with the higher net job growth in exporters. Market service sector is the direction where the second most movers change to. This corresponds to the fact that there have been a considerable amount of jobs reallocated from manufacturing to market service sector. And, the share of workers who move to the market service sector consistently increases with education level.

Table 12: Mobility of workers of exporters in manufacturing

		Education		
	All	1	2	3
Total workers	*165,186*	*47,155*	*90,548*	*27,483*
Stable workers	*0.840*	*0.829*	*0.849*	*0.835*
Movers	*0.160*	*0.171*	*0.151*	*0.165*
Direction of movement				
1. Other exporters in manufacturing	*0.190*	*0.150*	*0.202*	*0.224*
2. Non-exporters in manufacturing	*0.063*	*0.060*	*0.073*	*0.047*
3. Market service sector	*0.159*	*0.124*	*0.154*	*0.235*
4. Other sectors	*0.092*	*0.069*	*0.102*	*0.100*
5. Others	*0.496*	*0.597*	*0.469*	*0.394*
Total movers (=100%)	*26,360*	*8,114*	*13,721*	*4,525*

Notes:

(1) The exporters where the workers are counted from are the firms which keep status of exporter for at least two successive years. There is no control for the years of the status of the firms where they move to.

(2) All numbers are mean of annual values from 1996 to 2005.

(3) 1= low-educated, 2=medium-educated, 3=high-educated.

Table 13: Mobility of workers of non-exporters in manufacturing

		Education		
	All	1	2	3
Total workers	*53,877*	*16,553*	*30,473*	*6,851*
Stable workers	*0.714*	*0.686*	*0.734*	*0.734*
Movers	*0.286*	*0.314*	*0.266*	*0.266*
Direction of movement				
1. Other non-exporters in manufacturing	*0.134*	*0.120*	*0.148*	*0.117*
2. Exporters in manufacturing	*0.146*	*0.128*	*0.158*	*0.145*
3. Market service sector	*0.138*	*0.111*	*0.138*	*0.215*
4. Other sectors	*0.084*	*0.068*	*0.086*	*0.111*
5. Others	*0.498*	*0.573*	*0.470*	*0.412*
Total movers (=100%)	*15,412*	*5,299*	*8,252*	*1,861*

Notes:
(1) The non-exporters where the workers are counted from are the firms which keep status of non-exporter for at least two successive years. There is no control for the years of the status of the firms where they move to.
(2) All numbers are mean of annual values from 1996 to 2005.
(3) 1= low-educated, 2=medium-educated, 3=high-educated.

Table 14: Mobility of workers of high R&D-intensive exporters in manufacturing

		Education		
	All	1	2	3
Total workers	*52,048*	*10,971*	*26,998*	*14,079*
Stable workers	*0.839*	*0.833*	*0.843*	*0.839*
Movers	*0.161*	*0.167*	*0.157*	*0.161*
Direction of movement				
1. Other exporters in manufacturing	*0.269*	*0.232*	*0.273*	*0.255*
2. Non-exporters in manufacturing	*0.054*	*0.042*	*0.063*	*0.039*
3. Market service sector	*0.168*	*0.119*	*0.152*	*0.236*
4. Other sectors	*0.091*	*0.066*	*0.095*	*0.087*
5. Others	*0.418*	*0.541*	*0.417*	*0.383*
Total movers (=100%)	*8,379*	*1,846*	*4,258*	*2,275*

Notes:
(1) The exporters where workers are counted from are the firms which keep status of exporter for at least two successive years. There is no control for the years of the status of the firms where they move to.
(2) All numbers are mean of annual values from 1996 to 2005.
(3) 1= low-educated, 2=medium-educated, 3=high-educated.

With regards to the dissimilarity of worker reallocation between exporters and non-exporters, there is a larger share of workers who move to exporters and market service sector from exporters than from non-exporters. In contrast, the share of workers from non-exporters move to other non-exporters is more than double of that from exporters. This feature is still in effect even if we compare the numbers under each education level. This reveals a kind of regularity in that workers' reallocation is narrow in terms of firm's status in international trade. It might be true that the workers who are similar in other skills but have previous work experience in exporters comparatively easier find a new job in exporters, and the workers from exporters also have higher willingness to change to exporters than to non-exporters due to the premium of exporters in wage, productivity, and other aspects.[23] The implication that exporters prefer the workers with previous work experience in exporters reveals that workers carry over features related to firm's characteristics. Consequently, the concentration of reallocations within the group of firms with the same status in terms of international trade and R&D-intensity enhances the accumulated characteristics of firms. However, the sizable reallocation of workers from exporters to non-exporters each year may be a channel of knowledge externality (based on the fact that exporters possess the premium in productivity) and might influence the productivity growth in non-exporters.[24] But this hypothesis would require further studies to prove, which exceed the capacity of this paper.

Finally, we investigate the characteristics of reallocations for workers with different education levels. By comparing the numbers under the three education categories in the tables, we can see that the diversity of the reallocations of workers with different education levels is even greater in exporters than in non-exporters. The percentage of movers found in other firms is generally increasing with education level, except for the workers moving to non-exporters. The percentage of workers that move to non-exporters is greater for low and medium-

[23] Another possible explanation is that export is correlated with industry-specific factor and workers more likely reallocate within the same industry.

[24] On average there are 1660 workers move from exporters to non-exporters each year, and they account for 3% of total workers in non-exporters every year.

educated workers than for high-educated workers. This difference may be due to the involuntariness of high-educated workers to change to non-exporters or the lower requirement of non-exporters for high-educated workers which reflects to some extent the differences between exporters and non-exporters in the level of technology and productivity. It should be noticed that between the percentages of low- and medium-educated movers, the latter is higher than the former in all the directions of new firms. This exhibits that the preference for skilled workers has not only been prevailing in exporters but also in non-exporters, and this prevalence ultimately brings about changes in the skill composition of the overall labour force.

6 Conclusion

By using the matched trade data and employer-employee data, job reallocation and labour mobility among the heterogeneous firms in Norway have been investigated in this paper. As trade, R&D and knowledge activity are assumed to be the potential sources of growth, job reallocation and labour mobility are studied based on the classification of firms in terms of their status in international trade and R&D intensity, and the categorization of workers in terms of their education levels.

First, the results indicate that there have been a substantial amount of jobs and workers reallocated from manufacturing to market service sector, among which the especially high ratio of high-educated workers should be noticed. With respect to the restructuring within manufacturing, more jobs and workers are reallocated to exporting firms and high R&D-intensive industries. Among all exporters, high R&D-intensive exporters grow particularly fast. Net entry plays a significant role in the job growth of exporting sectors.

Second, there are differences between the knowledge-activity intensities of exporters and non-exporters illustrated by the education level of their employees. The upgrading of the labour composition by the increases of the share of medium- and high-educated workers has been carried out in both exporters and non-exporters, yet the progress is even faster in exporters. The worker stability in

exporters is markedly higher than that in non-exporters, not only for medium- and high-educated workers, but also for low-educated workers. Although the worker mobility in non-exporters is higher, the percentage of moving workers who find a new job within one year is quite similar with that in exporters. Most workers reallocate within the same sector and industry. Within manufacturing, most of the reallocations are between exporters, followed sequentially by the reallocations from non-exporters to exporters, between non-exporters and from exporters to non-exporters. The main trend is that workers are reallocated from less efficient firms to more efficient firms.

From this paper, we have seen the heterogeneity of firms in international trade in terms of employment patterns and other aspects. Nevertheless, it requires prudence to conclude whether the heterogeneity in employment patterns is a cause or an effect of the participation in international markets and to determine the relationship between employment and the other characteristics of firms needs further research. But in this paper we have reached the findings of the significant differentials in productivity and skill-composition of labour between trading and non-trading firms, and substantial reallocations of differently educated workers inter- and intra-subsectors of exporters and non-exporters. The reallocation of jobs and workers from non-exporters and low R&D-intensive firms to exporters and high R&D-intensive firms, as well as the improvement in the composition of the workforce within firms, are very likely to have a deep influence on the aggregate productivity growth.

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A Appendix

A.1 Data-set construction and statistical computation

When I calculate gross job flows, the workers who stayed in a job position for less than three months are eliminated for the purpose of avoiding spuriously high job flow rates, because our interest is mainly on the relatively long-term workers. Following Davis and Haltiwanger (1999), I compute job creations and job destructions from time *t-1* to time *t* by comparing the number of workers at the beginning of year *t-1* and the number of workers at the beginning of year *t* in a firm *e* or sector *s*. Hence, the job flow rates reflect the changes of jobs from one point to another point in the time. I work out the gross job flows for manufacturing, market service sector, as well as for the subsectors of trading firms and non-trading firms in manufacturing. The market service sector covers sale, repair, hotel, restaurant, transport, communication, financial intermediation, real estate, renting and other business activities. When exploiting the job flows of exporters, I decompose exporters to be stable exporters, changing exporters, exiting exporters and new entering exporters. The definitions are that if exporters didn't change the status from year *t-1* to year *t* (e.g. they were exporters in both years), they are defined as stable exporters. Oppositely, if firms changed status (from exporter to non-exporter or from non-exporters to exporters) they are defined as changing exporters. If exporters exited out of the market, they are exiting exporters. New entering exporters are the firms that started exporting in their first year.

When exploring the mobility of workers, I only use the full-time workers which are recorded as working 30 hours or more per week, and also recorded as working in a job position at least three months. Workers with missing education information and workers that worked in the firms which have classification both in manufacturing and market service sectors are excluded. After these eliminations, about 87% of workers in manufacturing, 90% of workers of exporters in manufacturing and 77% of workers in market service sectors are counted. There are 5% – 6% workers who have changed jobs in different firms at

least once within each year. For these workers, I only keep the job positions where the workers worked the longest time with the assumption that the longer the worker stays in a job the more he/she learns from the job. Using this method, the results are somehow like the lowest limit of the stability of workers, because the definition for the workers staying at the same firm is strict.

In the data after elimination, the observations in manufacturing are around 9,700 firms and 250,000 employees averagely each year. The exporters in manufacturing are around 3,000 firms but account for 70% of all employment in manufacturing on average each year. The number of firms observed in market service sector is around 58,480, with employment of about 563,000 on average each year.

A.2 Classification in high and low R&D-intensive industries

Industries in manufacturing are classified by their levels of R&D-intensity according to the number of R&D personnel at the industry level. R&D personnel numbers are taken from OECD Statistics. The industries with above average ratio of R&D personnel to the total number of workers in the industries are classified as high R&D-intensive industries, while the industries with below average ratio are classified as low R&D-intensive industries.

High R&D-intensive industries are Manufacture of chemicals and chemical products (SIC 24), Manufacture of machinery and equipment n.e.c. (SIC 29), Manufacture of office machinery and computers (SIC30), Manufacture of electrical machinery and apparatus n.e.c. (SIC 31), Manufacture of radio, television and communication equipment and apparatus (SIC32), Manufacture of medical, precision and optical instruments, watches and clocks (SIC 33), and Manufacture of motor vehicles, trailers and semi-trailers (SIC 34). The other industries in manufacturing are classified as low R&D-intensive industries.